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## GEIKIE'S GEOLOGY

*Geological Sketches at Home and Abroad.* By Archibald Geikie, LL.D., F.R.S. With Illustrations. (London and New York: Macmillan and Co., 1882.)

*Text-Book of Geology.* By Archibald Geikie, LL.D., F.R.S. With Illustrations. (London: Macmillan and Co., 1882.)

THESE two works, by the same author, are presented to the public at nearly the same time, but there is no other reason why they should be described together. The first is a collection of short papers, each presenting some matter of personal observation or some contribution to geological philosophy. The second exhibits the science of geology in a systematic way, and of necessity deals chiefly with the results of the work of others. The first is addressed to the general reader, and in part to the geologist; the second is addressed specifically to the student.

The sketches of the first volume are not new, but are here collected for the first time. Several of them received their first publication as magazine articles, others have been presented to scientific societies, and a few have taken the form of lectures. They constitute but a small portion of the author's voluminous contributions to scientific literature, and have evidently been selected because of their popular interest. A few are addressed to the popular audience only, and merely present some of the elements of stratigraphical and dynamical geology, with familiar Scottish scenes as texts; but the majority embody original contributions to knowledge, couched in so simple language that the layman reads them without being fully aware that they belong to the frontier of geological thought. Prof. Geikie possesses the happy faculty of addressing himself simultaneously to a professional and an unprofessional audience in such way that the former do not find his science too dilute nor the latter too condensed.

One of the sketches describes a journey to central France, undertaken for the purpose of studying the extinct volcanoes of that region as an aid to the imagination in restoring the condition of Scotland during the Carboniferous period; and another describes a journey to Norway with the parallel purpose of rendering vivid the mental restoration of Scotland in Glacial times. These two are perhaps the most instructive of the collection, for besides making definite additions to the geological history of Scotland, they present admirable illustrations of one of the most valuable methods of scientific investigation. The principles which distinguish modern scientific research are not easily communicated by precept, and it is by no means certain that they have yet been correctly formulated. However it may be in the future it is certain that in the past they have been imparted, and for the present they must be imparted, from master to pupil chiefly by example; and whoever in publishing the result of a scientific inquiry sets forth at the same time the process by which it was attained, contributes doubly to the cause of science.

Two chapters are devoted to a journey in the United States; a journey undertaken, like the others, for a definite purpose—that of enabling the author to see with his own eyes the monuments of erosion for which the Rocky Mountain region is so illustrious. His account deals also with a variety of geological topics, as well as with the peculiar aspects of American frontier life. He describes the geysers of the Yellowstone country, some of the extinct glaciers of the head-waters of the Missouri, the parallel shore-lines of the great extinct lake of Utah, and the great lava field of the Snake River Plain. In another chapter he appears as the apostle of massive eruptions, first recognised by Richthofen, and afterwards by many American geologists, but so foreign to European experience, that the accounts of them had seemed to many English geologists to border on the marvellous, and had even thrown discredit upon American science.

Perhaps the most important paper of all is that upon geographical evolution. It was originally read to the Royal Geographical Society, and has received in various ways so wide a publication, that it is probably accessible already to the majority of the readers of NATURE. The lecture on the weathering of rocks, as illustrated by tombstones, is also included, and a lecture on the geological influences which have affected the course of British history.

In the whole collection there is nothing polemic, nor anything that could even be called controversial. Attention is never directed to an error, except as the merest incident to pointing out that which is true. No words are given to the censure of others, but many to their praise, and one of the chapters has for its theme a eulogy on the work of the early Scottish school of geology.

The style is peculiarly genial and entertaining—a merit unfortunately rare in the writings of modern geologists; but accuracy of statement is not sacrificed to vivacity. As in all his writings, there is nothing sensational, either in description or in speculation. His inductions are not expanded into brilliant, universal theories, but are modestly advanced with all those limitations which impress themselves on the mind of one who constantly questions nature.

Turning now to the text-book, we come to consider a work of greater importance, and one especially deserving of careful criticism by reason of its relation to education. The text-books of this generation must furnish to the geologists of the next their fundamental principles, so that those who prepare them and those who commend them are responsible, not merely to the youth of to-day, but to the science of the future.

There are four features in regard to which a work designed for geological instruction should be scrutinised: Its scope, the arrangement of its matter, the quality of its matter, the manner of presentation.

In the scope of geological text-books, on the range o subjects considered and the relative space allotted to each, there has been a progressive development, parallel with and dependent upon the evolution of geology and cognate sciences. Our knowledge of the earth's history is so dependent upon and interwoven with other departments of knowledge, that a clear presentation of it cannot be made without either reciting the elements of other sciences or assuming them to be known. In the early history of the subject, when the volume of geological material was small, and when the elements of zoology,

botany, and chemistry were not so widely diffused as now, it appeared to most writers necessary to devote some space, either in a prefatory or in an incidental way, to these sciences. Mineralogy and palæontology, growing with the growth of geology, were likewise treated with it. But owing to the rapid development of geology, its own subject matter has now become so voluminous that it can only with difficulty be outlined in the compass of a text-book, and step by step it has displaced everything of which a sufficient knowledge could be assumed.

While mineralogy and palæontology have by their growth become more and more differentiated from geology, astronomy has been affiliated in a degree that was not anticipated. Previous to the revelations of the spectroscope, our earth was regarded indeed in origin, composition, and career as analogous to other planets, but only in a hypothetic and speculative way; but now that there is a large body of evidence pointing to identity of composition throughout the solar system, there is no longer any question of a common history, and every advance in celestial physics is now regarded as a contribution to the early history of the earth. A department of astronomical geology has thus arisen.

In the work under consideration no space whatever is permitted to zoology and botany; chemistry is barely mentioned; mineralogy (chiefly descriptive) is accorded only 25 pages; palæontology proper is omitted, but 28 pages are devoted to the principles of palæontological geology—a department of science clearly distinguishable if not distinct from palæontology, and inseparable from stratigraphy; mythological cosmogony is not even mentioned, but the space it has too often occupied is given to physiographical geology—a discussion of the origin of the physical features of the land. Astronomical geology is accorded 23 pages. The bulk of the volume—570 pages out of 910—is devoted to geognosy, and dynamical and structural geology that is, to rocks and rock structures, and to the physical changes whereby rocks originate. Stratigraphy, which until very recently has arrogated the lion's share of space, is here reduced to less than one-third of the total.

The distribution of space thus outlined is eminently judicious, and it may be doubted whether any could be better adapted to the present status of the science and the present demands of instruction. If it has a fault it is in the amount it concedes to the demands of the geologist in the matter of stratigraphy. The student's text-book has not yet been clearly differentiated from the geologist's handbook, and there is certainly an open field to-day for a manual specially adapted to the use of the working geologist, and not primarily arranged for instruction. All of the larger text-books have been partially adjusted to this need, and Prof. Geikie's is not an exception; but in his work the adjustment appears only in the stratigraphical chapter, which embodies a mass of detail that can serve only to bewilder if the student undertakes to master it. If the 275 pages of descriptive stratigraphy were reduced to 50, and a portion of the space thus saved were devoted to a rapid review of the salient points of the geological history of some limited region, as Great Britain, for example, I am prone to believe that the student would be afforded a better insight into the aims and results of geological inquiry.

In the classification and arrangement of the subject-matter of geological text-books, there has been as marked a development as in the scope. The number of different manners in which a congeries of allied topics can be grouped is practically limitless, for the bases of possible groupings are as numerous as the relations sustained by the topics; but not all classifications are of equal utility, and at each stage in the progress of a science there is usually some one which commends itself as of superior advantage. As, in the progress of knowledge, new relations are discovered, and the importance of relations previously known comes to be differently estimated, new classifications are adopted, in comparison with which the old appear crude. Geology is so young a science, that a single generation has witnessed a complete revolution in this regard. The primary classifications of the modern text-books have nothing in common with the earlier editions of Lyell's manual. In the division and arrangement adopted by Geikie, only a single feature is original, but the order of presentation as a whole is new.

The theme of geology is the history of the earth. In its study there are two lines of inquiry, which are so nearly independent that they form co-ordinate branches of the general theme: the one is cosmic, the other terrestrial.

Cosmically considered, the earth is one of a group of worlds believed to have a common origin, and to be pursuing parallel courses of development, in which they have reached various different stages. Assuming this to be true, the less developed worlds present phases, through which the earth has already passed, and by studying them we may learn something of the youth of our planet.

The terrestrial branch of inquiry is concerned chiefly with rocks. The changes of the crust have led to the formation of rocks, and have given to them great variety of composition and structure. It is known, moreover, that rock formation is still in progress, and that agencies whose operations can be witnessed are now forming many varieties of rocks, and are initiating many peculiarities of rock structure. It is possible, therefore, to associate certain rocks and rock structures with certain processes of change, and by this means to derive from a study of the rocks of the crust a history of the changes which led to their formation. This inquiry is greatly facilitated by the fact that rocks have been partly formed from animal and vegetable remains, and by the additional fact that there has been a progressive development of life; so that, the key once obtained, the chronological order of rocks can be deduced from their organic contents.

In presenting the second line of inquiry as to the earth's history it is therefore proper to treat: of the composition of rocks and other materials of the earth's crust (geognosy); of the forms in which rocks are aggregated, or the structure of rock masses (structural geology); of the agencies which in modern times are observed to produce changes of the earth's crust (dynamical geology); of the relation of organic remains to geological formations (palæontological geology); and finally, of the actual order in which the various kinds and groups of rocks succeed each other, and the deduced series of changes the earth has undergone (stratigraphical or historical geology). The first and last of these categories claim their respective positions without question: geognosy constitutes the alphabet of the sub-

ject, and must precede all else, while stratigraphical geology depends upon all the other divisions, and must follow them. Palæontological geology is in some sense co-ordinate with dynamical and structural geology taken together, but finds place after them because its use cannot be explained before their principles are known. Whether dynamical geology should precede or follow structural, is a question admitting of discussion. They are to a large extent correlatives, and either is more intelligible if preceded by the other. To give precedence to structural geology is to describe phenomena in advance of their explanation. If dynamical geology precedes, a variety of natural agents are described which have no apparent connection with the general subject. The majority of writers have selected the former alternative; but a few have preferred the latter, and among them our author. All things considered, he appears to have chosen the lesser evil.

The single new departure of the volume consists in the elevation of physiographical geology to the rank of a major division. The same title it is true has been placed by Dana at the head of a primary division of the subject, but it was used by him in a different sense. With Dana it is a synonym for physical geography; with Geikie it is that "branch of geological inquiry which deals with the evolution of the existing contours of the dry land." So far as the subject has had place in earlier treatises it has been regarded as a subdivision of dynamical geology, and the classification which placed it there was certainly logical. In dynamical geology, as formulated by Geikie, the changes which have their origin beneath the surface of the earth (volcanic action, upheaval, and metamorphism), and the changes which belong exclusively to the surface (denudation and deposition) are separately treated. In physiographical geology the conjoint action of these factors of change is considered with reference to its topographical results. Starting from geological agencies as data we may proceed in one direction to the development of geological history, or in another direction to the explanation of terrestrial scenery and topography, and if the development of the earth's history is the peculiar theme of geology, it follows that the explanation of topography, or physiographical geology, is of the nature of an incidental result—a sort of corollary to dynamical geology. The systematic rank assigned to it by Geikie is an explicit recognition of what has long been implicitly admitted: that geology is concerned quite as really with the explanation of the existing features of the earth as with its past history. The separation initiated by our author is an indication of the growing importance of the subject, and it is safe to predict that in the future it will not merely retain its new position, but will even demand a larger share of space.

The following scheme exhibits the general plan of the volume:—

Book 1.—Cosmical aspects of geology.

Book 2.—Geognosy: an investigation of the materials of the earth's substance.

Book 3.—Dynamical geology.

Book 4.—Geotectonic geology; or the architecture of the earth's crust. (*Geotectonic* is a new term proposed as a substitute for *structural*).

Book 5.—Palæontological geology.

Book 6.—Stratigraphical geology.

Book 7.—Physiographical geology.

Comparing this classification with that of other authors, and viewing it with reference to the present condition of the science, we may say without hesitation that it has no superior, and that it is well adapted to existing needs.

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(*To be continued.*)

## OUR BOOK SHELF

*Uniplanar Kinematics of Solids and Fluids; with Applications to the Distribution and Flow of Electricity.* By George M. Minchin, M.A. Pp. viii. + 266. (Oxford: Clarendon Press, 1882.)

IN subject-matter this book is almost unique among our mathematical manuals. The only fellow to it is Clifford's "Kinematic." It consists of six chapters, the first dealing with Displacement and Velocity, the second with Acceleration, the third with Epicycloidal Motion, the fourth with the Mass-Kinematics of Solids, the fifth with the Analysis of Small Strains, and the sixth almost as long as the others put together, with the Kinematics of Fluids. The subdivisions of the last chapter are headed —General Properties: Multiply Connected Spaces; Motions due to Sources and Vortices, Electrical Flow; Conjugate Functions. There is also a short appendix, with notes on such subjects as Vectors and their Derivatives, Current-Power, and Routh's Use of Conjugate Functions.

It is impossible, without occupying considerable space, to give an adequate idea of the freshness and originality which mark Prof. Minchin's work. These are notable in the exceedingly valuable sixth chapter, but even on such well-worn subjects as velocity and acceleration, he treats us to many pleasant little surprises. Nor is this accomplished at the expense of the student; the clearness, fulness, and good arrangement specially requisite in a college text-book are all of them conspicuous; and valuable collections of exercises, worked and unworked, and given at intervals. The book is altogether one for which success may be cordially wished, not merely as a reward to the author, but in order that the science of which he treats may go on as steadily and rapidly advancing as it has of recent years been doing.

*Die Käfer Westfalens.* Zusammengestelt von F. Westhoff. Abtheilung ii. (Supplement zu den Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande und Westfalens, Jahrgang 38, pp. 141-323.) (Bonn, 1882.)

WE have already noticed the first part of this work in NATURE. The second and concluding portion is now before us. It forms one of the most useful local Beetle catalogues that we have seen, nicely printed (the names being in bold black type), with copious local and other information. The district comprises about 450 square (German) miles, and is varied in its physical conditions. In all, 3221 species are enumerated, in 59 families. The *Staphylinidæ* comprise 667 species, *Curculionidæ* 471, *Carabidæ* 321, *Chrysomelidæ* 265, and *Dytiscidæ* 115. All the other families have each less than 100 representatives, and 10 of them less than 5. The nomenclature followed is that of the newest "Stein-Weise" German list, which, as is well known, has introduced a great multitude of changes and innovations; but other generally received names are indicated in brackets, thus avoiding confusion. Westhoff describes no new species in Part ii., but indicates and names a good many new (chiefly colour) varieties. Probably the rage for naming colour-varieties, so wide-spread at the present day, should be deprecated. For instance, in this catalogue we find a list of 27 named